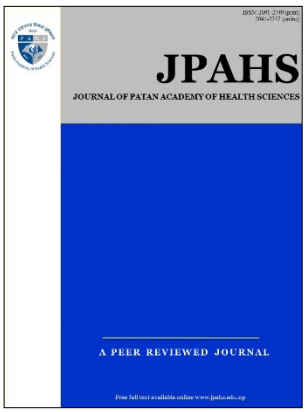

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Dexmedetomidine as an adjunct to bupivacaine and xylocaine with adrenaline in ultrasound guided supraclavicular brachial plexus block in upper limb surgeries

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Abstract

Introduction: Supraclavicular brachial plexus blocks are widely used for perioperative anesthesia and analgesia. Dexmedetomidine is a highly selective alpha-2 receptor agonist that provides analgesia, sedation, and anxiolysis. Our study aims to evaluate the effect of the addition of dexmedetomidine with bupivacaine and xylocaine with adrenaline in supraclavicular block in upper limb surgeries.

Method: This was a comparative study conducted at Patan Hospital, Nepal among 44 patients randomly assigned in Group-I (N=22, bupivacaine and xylocaine with adrenaline 28 ml + dexmedetomidine 2 ml 1 mcg/kg), and Group-II (N=22, without dexmedetomidine) for ultrasound-guided supraclavicular block for upper limb surgeries. The study was approved by the institutional review committee. Onset of sensory and motor block, duration of analgesia, demographics, hemodynamic parameters, and side effects of drugs were compared. The Pin-prick test and the modified Bromage scale were used to evaluate sensory and motor blockades and the visual analogue scale for the severity of pain. Statistical analysis was performed with SPSS v16.

Result: The median time for the onsets of sensory and motor blocks was significantly shorter in GI (1 m and 3 m) than in GII (5 and 10 m). The duration of analgesia was longer in group I (720 m) than in group II (360 m). Two patients had bradycardia and one had hypertension in the dexmedetomidine group, which were managed successfully.

Conclusion: Dexmedetomidine added to local anesthetics significantly prolongs the effect of supraclavicular block in upper limb surgeries.

Keywords: Bupivacaine, dexmedetomidine, supraclavicular block, ultrasound guided, upper limb surgery, xylocaine with adrenaline

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Introduction

In modern anesthesia, the regional nerve block technique has become popular to avoid unwanted side effects of anesthetic drugs used in general anesthesia.[1] Supraclavicular brachial plexus block is widely used to provide perioperative anesthesia as well as postoperative analgesia in upper limb surgeries.[2] It also maintains hemodynamic variables without sedation thus facilitating early mobilization and discharge.[3] Bupivacaine is a moderate-acting local anesthetic. So adjuncts such as dexamethasone[4,5], morphine[6], fentanyl[7], tramadol[8], clonidine[9], midazolam[10] are used to prolong the effect of Bupivacaine in the supraclavicular block. Dexmedetomidine is a highly selective alpha-2 receptor agonist which provides analgesia, sedation, and anxiolysis.[11] Data on its use in supraclavicular brachial plexus block is limited locally. We routinely use bupivacaine and xylocaine with adrenaline in the supraclavicular brachial plexus block in our institution. The present study aims to evaluate the effect of dexmedetomidine when used with bupivacaine and xylocaine + adrenaline in the supraclavicular block in prolonging sensory and motor block.

Method

This was a comparative study conducted in the Department of Anesthesiology, Patan Hospital, Patan Academy of Health Sciences (PAHS), Nepal from August 2021 to October 2021. After the approval from the Institutional Review Committee (IRC-PAHS, Ref: drs2108101564), 44 adults (18-60 y), ASA I-III were randomly enrolled into two groups of 22 each. The sample size was calculated by using the formula $n=\{2(z\alpha+z\beta)^2 \text{ X } SD^2\}/d^2$, where $z\alpha=1.96$ at 95% confidence interval and $z\beta=1.64$ at 95% power, on the basis of mean onset of sensory block of dexmedetomidine+bupivacaine.[12] Patients with a history of cardiovascular disease, liver, and renal impairment, hypersensitivity to drugs, neuromuscular and psychiatric disorder, long-term analgesic for chronic disease, pregnancy, lactating mothers, skin lesion at the site of injection and block failure were excluded. Informed consent was obtained and the patient had the right to withdraw from the study.

A preanesthestetic checkup (PAC) was done one day before the surgery. Patients were randomly allocated in groups I and II by sealed envelope technique. Group I patient received 0.5% bupivacaine and 2% xylocaine with adrenaline 28 ml + dexmedetomidine 2 ml (1 mcg/ml) and group II received 0.5% bupivacaine with 2% xylocaine with adrenaline 28 ml + normal saline 2 ml in supraclavicular block. An intravenous drip was started before undertaking the procedure with an 18 G cannula during surgery for maintenance fluid. Heart Rate (HR), systolic (SBP) and Diastolic Blood Pressures (DBP), and Oxygen Saturation (Spo2) was recorded just before the block and at 5 m intervals thereafter. The patient was kept supine and head turned to the opposite side for the block. The injection site for the block was prepared by an aseptic technique using povidone-iodine. The ultrasound-guided block was performed using a 4-inch stimuplex needle. Direct visualization of the hypoechoic structure was done and infiltrated with designated drugs using an in-plane approach. Negative aspiration was done repeatedly to avoid any intravascular injection. The anesthesia assistant not involved in the study filled up the form after evaluating the onset of sensory block and motor block.

Sensory block was tested using the pinprick method and assessed by 3-point scale: 0 = normal sensation, 1 = loss of sensation to pinprick (analgesia), 2 = loss of sensation to touch (anesthesia). The palmar surface of the index and little finger was used to test the median and ulnar nerve block in the hand, respectively. To test the radial nerve the dorsal surface of the thumb was used. The time of onset of acceptable sensory block was defined as the interval between the completion of injection and loss of pain in pinprick sensation (grade 1). Duration of sensory block was defined as the time interval between the

complete sensory block and complete resolution of anesthesia in all nerves (score 0).

Motor block was tested by thumb adduction (ulnar nerve), thumb abduction (radial nerve), flexion of the elbow, and pronation of forearm (musculocutaneous nerve), and thumb opposition (median nerve). Motor block was assessed by modified Bromage Scale:

0. Able to raise the extended arm to 90^0 for full two seconds
1. Able to flex the elbow and move the fingers but unable to raise the extended arm
2. Unable to flex the elbow but able to move fingers
3. Unable to move the arm, elbow, or fingers

The onset time of acceptable motor block was defined as the time between the completion of the local anesthetic injection and unable to flex the elbow but able to move the fingers (grade 2). Duration of motor block was defined as the time interval from complete motor block to complete recovery of motor function of hand and forearm (grade 0).

Both sensory and motor block were assessed every minute till acceptable sensory and motor blockade of the whole arm was achieved or 30 minutes whichever is shorter. Score 1 for sensory and score 2 for the motor block was considered adequate for the procession of surgery. In the event of failure to achieve acceptable sensory and/or acceptable motor blockade, the patient was administrated general anesthesia. The patient was asked for any uneasiness like nausea, vomiting, circum-oral numbness, or feeling of faintness as features of complication to local anesthesia. Any adverse effects like bradycardia, hypotension, hypertension, nausea, vomiting, hypoxemia (SpO2 <90%) were recorded and managed as per anesthesia department protocol. Intraoperative use of any additional drug was also recorded.

Visual Analogue Score (VAS) consisting of 10 cm line, 0= no pain and 10= worst possible pain was used in the postoperative ward to assess pain every 15 m in 1^{st} h, then 30 m in 2^{nd} h and then hourly. Rescue analgesia as per orthopedic department's protocol (inj. ketorolac 30 mg) when VAS >5 or when patient demanded control of pain. Duration of analgesia (DOA) was considered from the time of onset of acceptable sensory block in the operation theater until the administration of rescue analgesia.

Data analysis was performed by Statistical Package for Social Sciences, SPSS version 16. Mean ± standard deviation (SD) was calculated for age. The student's t-test was applied for demographic and hemodynamic variables like age, weight, heart rate, blood pressure, and mean arterial pressure. The Chi-square test was used to see the association between the groups for categorical variables like gender, ASA physical status, VAS, and adverse effects. Mann Whitney U test was applied for the onset of sensory block, the onset of motor block, and duration of analgesia. A p-value <0.05 was considered statistically significant.

Result

The Male: Female ratio was 2.28, for Gr-I 2.83 and Gr-II 1.87. The mean weight for Gr-I was 59.83±10.89 and for Gr-II was 58.43±7.83, Table 1. Hemodynamic parameters had no significant difference in the two groups, Table 2.

The onset of sensory and motor block was statistically significant among the two groups (p<0.001). The median time for the sensory block was 1 m in the Gr-I and 5 m Gr-II. The median time for the motor block was 3 m in the Gr-I and 10 m in Gr-II, Table 3.

Duration of analgesia was significantly different among the two groups Gr-I 720(540-840) m, and 360 (300-420) m Gr-II, p<0.001 (Mann Whitney U Test).

In Gr-I, two patients had bradycardia and one patient had hypertension. Two patients in Gr-I and three in Gr-II were anxious during the procedure and were sedated with intravenous midazolam 2mg after onset of sensory and

motor block were noted. . Other side effects like nausea, vomiting, hypotension, hypoxia, respiratory distress, local anesthesia toxicity were not found in any groups.

Table 1. Demographic characteristics of respondents of two groups in ultrasound guided supraclavicular brachial plexus block

Characteristics	Category	Group 1 Dexmedetomidine + Bupivacaine and xylocaine with adrenaline	Group 2 Bupivacaine and xylocaine with adrenaline	p-value
Age in Years Median Age(Q1-Q3)=34 (23-42)	-	36 (26-43)	26 (20-40)	0.162#
Gender M:F ratio=2.28	Male	17	15	0.522*
	Female	6	8	
Weight Mean Weight (SD)	-	59.83±10.89	58.43±7.83	0.621#
ASA	ASA I	18	20	0.437*
	ASA II	5	3	

*Chisquare test at 95% CI; $Mann Whitney U test; # Student's t-test

Table 2. Comparison of hemodynamic characteristics at a different period after procedure among two groups in ultrasound guided supraclavicular brachial plexus block

Variables		Group 1, mean±SD	Group 2, mean±SD	p-value
SBP (mmHg)	5 m	126.70±20.76	125.74±19.26	0.872
	15 m	127.43±22.20	122.96±17.24	0.449
	30 m	123.26±20.31	121.09±17.38	0.699
	45 m	128.04±21.43	122.21±13.46	0.310
	1 h	126±21.35	124.64±18.33	0.863
	2 h	128.62±18.46	133.25±21.34	0.705
DBP (mmHg)	5 m	78±11.26	75.74±10.08	0.477
	15 m	78.22±13.64	74±9.93	0.237
	30 m	76.57±13.24	73.35±9.77	0.354
	45 m	79.7±14.32	76.05±11.20	0.372
	1 h	79.76±13.27	75.18±12.08	0.364
	2 h	69.25±27.56	76.33±16.25	0.691
MAP (mmHg)	5 m	96.09±14.42	93.61±12.21	0.533
	15 m	95.74±14.85	91.78±12.64	0.336
	30 m	93.74±15.73	91.61±12.27	0.611
	45 m	97.26±15.13	92.95±13.17	0.336
	1 h	95.94±15.27	95.55±13.75	0.945
	2 h	96.38±13.09	98.50±19.84	0.827
SpO2	5 m	95.48±4.58	95.78±3.04	0.792
	15 m	95.87±3.85	96.39±2.46	0.587
	30 m	94.96±4.54	96.43±1.90	0.157
	45 m	95.78±4.14	96.42±2.11	0.546
	1 h	97±2.15	96.55±2.87	0.636
	2 h	97.38±1.76	96±3.46	0.392
VAS score	15 m	0	0	-
	45 m	0	0	-
	60 m	0	0	-
	120 m	0	0	-
	180 m	0	0	-

SBP- systolic blood pressure, DBP- diastolic blood pressure, MAP- mean arterial pressure, SpO2- Oxygen saturation, VAS- visual analog scale, p-value by t-test

Table 3. The onset of sensory and motor block among respondents of two groups in ultrasound guided supraclavicular brachial plexus block

Onset of block (m)	Group 1 Median (Q_1-Q_3)	Group 2 Median (Q_1-Q_3)	p-value
Sensory	1 (1-2)	5 (5-5)	**<0.001**[$]
Motor	3 (2-4)	10 (10-15)	**<0.001**[$]

[$] Mann Whitney U Test; **Bold** Statistically Significant (p<0.05)

Table 4. Side effects and sedation required among two groups in ultrasound guided supraclavicular brachial plexus block

Side Effects	Group 1 N(%)	Group 2 N(%)
Bradycardia	2	0
Hypotension	0	0
Hypertension	1	0
Nausea	0	0
Hypoxia	0	0
Respiratory Distress	0	0
Anxious (sedation with midazolam)	2	3

Discussion

In our study, the use of dexmedetomidine with bupivacaine and xylocaine with adrenaline had early onset of sensory and motor block and significantly prolonged the duration of analgesia. We found that the median time for onset of sensory block and motor block was 1 m and 5m respectively. The duration of analgesia was 720m. Our findings of significantly shortened onset of the sensory block with the addition of dexmedetomidine correlates with previous studies that reported the addition of dexmedetomidine with 2% lidocaine significantly reduced the onset time of sensory and motor block and also increased the duration of analgesia.[12] In this study the onset time for the sensory block was 10.28±1.16 m, for the motor block was 14.72±1.67m, and the duration of the sensory block was 149.03±26.34 m. Similarly, in other studies when dexmedetomidine was used with bupivacaine, it prolonged the duration of sensory and motor block and had earlier onset of action.[13] Here, the onset time for the sensory block was 21.36±8.34m, for motor block 15.93±6.36m, and duration of sensory block was 475±137.5m. Comparing the results with our study, the onset time for sensory and motor blocks was very early. It may have accounted due to the additive effect of the drug on each other's potency as we have used dexmedetomidine with a combination of bupivacaine and xylocaine with adrenaline rather than using local anesthetics alone. This will facilitate early incision time and early pain relief. The prolonged duration of analgesia will provide the patient with a satisfactory intraoperative and postoperative period with decreased consumption of analgesia.

Since ultrasound-guided brachial plexus block has many advantages but is limited by the fixed duration of blockade and analgesia, many drugs have been used to enhance the property of local anesthetic and prolong the duration of the block.[14] Dexmedetomidine is recently popular as an adjunct to local anesthetics in a supraclavicular block. Dexmedetomidine is an alpha-2 agonist with higher selectivity for alpha-2 receptors than alpha-1. It prolongs the effect of local anesthetic agents without increasing the side effects when used in perineural injection in brachial plexus block. It also has analgesic, sedative, anesthetic, and hemodynamic stabilizing effects. It also produces semi arousable sedative state. It has an onset of action of about 5-15 min and lasts for 3-4 hours. Although the mechanism of dexmedetomidine is poorly understood, it may be caused by decreased norepinephrine release and a receptor-independent inhibitory effect on nerve fiber action potential.[15] The other hypothesized mechanism of

dexmedetomidine is that it inhibits the function of sodium channels and neuronal potassium current [16,17,18] and blocks the hyperpolarization-activated cyclic nucleotide-gated channels, resulting in the enhancement of activity-dependent hyperpolarization[19] and leading to the inhibition of substance P release in the nociceptive pathway at the dorsal root neuron.[20]

We chose a lower dose (1mcg/kg) of dexmedetomidine because we aimed to provide a satisfactory block without any or fewer side effects. A dose higher than 1mcg/kg showed more side effects and was not regarded ideal in the previous study.[14] The use of dexmedetomidine was associated with bradycardia and hypotension as side effects. It might be because of the inhibition of sympathetic outflow and release of norepinephrine through alpha-2 subtype receptors.[21,22] But this is transient and could be reversed. In our study, two patients receiving dexmedetomidine had bradycardia and were treated with injection glycopyrrolate 0.2 mg intravenously; and one patient had hypertension which was treated with Injection Glyceryl trinitrate 150 mg. In addition to this, due to its sedative property, after administration of block, patients were adequately sedated and there was no need for administration of other sedatives except for few patients. It might be due to systemic reabsorption.[23]

The limitation of our study is that it was conducted in a relatively small group of the population, so larger population size and use of dexmedetomidine in different nerves need to be considered to give better insight into its efficacy, safety profile, and cost-effectiveness.

Conclusion

Onset of sensory and motor block was significantly faster when dexmedetomidine was added to local anesthetics in a supraclavicular block. Addition of dexmedetomidine also prolonged the duration of analgesia.

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Conflict of Interest

None

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Author Contribution

Concept, design, planning: All (AS, AS, RP, MP, SPA, NH, BG, AS); Literature review: AS, AS, AS; Data collection: AS, RP, AS, MPA, NH; Data analysis: ALL; Draft manuscript: AS; Revision of draft: ALL; Final manuscript: ALL; Accountability of the work: ALL

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